Amendment to the Claims

In the Claims:

Please amend Claim 11 and Claim 20 as follows:

1. (Original) A method for automatically determining a contour of a left ventricle of a heart, based upon digital image data from a contrast-enhanced left ventriculogram, said image data including a sequence of image frames of the left ventricle made over an interval of time during which the heart has completed more than one cardiac cycle, said method comprising the steps of:

(a) from the sequence of image frames, choosing end diastole (ED) and end systole (ES) image frames to be segmented;

(b) indicating anatomic landmarks in the ED and ES image frames that were chosen;

(c) calculating a pre-determined set of feature images from the sequence of image frames, the ED and ES image frames, and the anatomic landmarks, the step of calculating including the step of de-flickering the image frames to substantially eliminate variations in intensity introduced into the image data when the left ventriculogram was produced;

(d) training a pixel classifier for a given set of feature images, using manually segmented ventriculograms produced for other left ventriculograms as training data;

(e) extracting boundary pixels by using the pixel classifier to classify pixels that are inside and outside of the left ventricle in the ED and ES image frames; and

(f) fitting a smooth curve to the boundary pixels extracted from the classifier output for both the ED and ES image frames, to indicate the contour of the left ventricle for ED and ES portions of the cardiac cycle.

2. (Original) The method of Claim 1, wherein the step of calculating the pre-determined set of feature images includes the step of masking the ventriculogram image frames with a mask that substantially excludes pixels in the ventriculogram image frames that are outside the left ventricle.

///

///

///

///

///

LAW OFFICES OF RONALD M. ANDERSON
600 - 108th Avenue N.E., Suite 507
Bellevue, Washington 98004
Telephone: (425) 688-8816 Fax: (425) 646-6314

3. (Original) The method of Claim 1, wherein the step of de-flickering comprises the steps of:

(a) applying a mask to the sequence of image frames;

(b) determining a gray-level median image; and

(c) using repeated median regression to produce de-flickered image frames.

4. (Original) The method of Claim 1, wherein the pixel classifier includes two stages, including a first stage classifier and a second stage classifier that operate sequentially, so that an output of the first stage classifier is input to the second stage classifier.

5. (Original) The method of Claim 4, further comprising the step of spatially blurring the output of the first stage for input to the second stage.

6. (Original) The method of Claim 4, wherein each of the first and the second classifier stages includes separate ED and ES classifiers.

7. (Original) The method of Claim 6, wherein the ED and ES classifiers comprise decision trees.

8. (Original) The method of Claim 6, wherein the ED and ES classifiers are boosted decision trees that use an AdaBoost.M1 algorithm for classifying images.

9. (Original) The method of Claim 1, wherein the step of fitting the smooth curve includes the step of determining the boundary pixels using dilation and erosion.

10. (Original) The method of Claim 1, wherein the step of fitting the smooth curve includes the steps of:

(a) generating a control polygon for a boundary of the left ventricle in the contrast-enhanced left ventriculogram, with labels corresponding to the anatomic landmarks;

(b) subdividing the control polygon to produce a subdivided polygon having an increased smoothness;

(c) rigidly aligning the subdivided polygon with the anatomic landmarks of the left ventricle; and

(d) fitting the subdivided polygon with the ED and ES image frames and the anatomic landmarks, to produce a reconstructed border of the left ventricle for ED and ES.

///

///

LAW OFFICES OF RONALD M. ANDERSON
600 - 108th Avenue N.E., Suite 507
Bellevue, Washington 98004
Telephone: (425) 688-8816 Fax: (425) 646-6314

11. (Currently Amended) A system for automatically determining a contour of a left ventricle of a heart, based upon digital image data from a contrast-enhanced left ventriculogram, said image data including a sequence of image frames of the left ventricle made over an interval of time during which the heart has completed more than one cardiac cycle, comprising:

(a) a display;

(b) a nonvolatile storage for the digital image data and for machine language instructions used in processing the digital image data; and

(c) a processor coupled to the display and to the nonvolatile storage, said processor executing the machine language instructions to carry out a plurality of functions, including:

(i) from the sequence of image frames, choosing end diastole (ED) and end systole (ES) image frames to be segmented;

(ii) indicating anatomic landmarks in the ED and ES image frames that were chosen;

(iii) calculating a pre-determined set of feature images from the sequence of image frames, the ED and ES image frames, and the anatomic landmarks, the step of calculating including the step of de-flickering the image frames to substantially eliminate variations in intensity introduced into the image data when the left ventriculogram was produced;

(iv) training a pixel classifier for a given set of feature images, using manually segmented ventriculograms produced for other left ventriculograms as training data;

(v) extracting boundary pixels by using the pixel classifier to classify pixels that are inside and outside of the left ventricle in the ED and ES image frames; and

(vi) fitting a smooth curve to the boundary pixels extracted from the classifier output for both the ED and ES image frames, to indicate the contour of the left ventricle for ED and ES portions of the cardiac cycle.

12. (Original) The system of Claim 11, wherein the machine instructions further cause the processor to mask the ventriculogram image frames with a mask that substantially excludes pixels in the ventriculogram image frames that are outside of a left ventricle.

///

///

///

LAW OFFICES OF RONALD M. ANDERSON
600 - 108th Avenue N.E., Suite 507
Bellevue, Washington 98004
Telephone: (425) 688-8816 Fax: (425) 646-6314

13. (Original) The system of Claim 11, wherein the machine instructions de-flicker the image frames by:

(a) applying a mask to the sequence of image frames to substantially exclude pixels that are outside of a left ventricle;

(b) determining a gray-level median image; and

(c) using repeated median regression to produce de-flickered image frames.

14. (Original) The system of Claim 11, wherein the pixel classifier includes two stages, including a first stage classifier and a second stage classifier that operate sequentially, so that an output of the first stage classifier is input to the second stage classifier.

15. (Original) The system of Claim 14, wherein the machine instructions further cause the processor to spatially blur the output of the first stage for input to the second stage.

16. (Original) The system of Claim 14, wherein each of the first and the second classifier stages includes separate ED and ES classifiers.

17. (Original) The system of Claim 16, wherein the ED and ES classifiers comprise decision trees.

18. (Original) The system of Claim 16, wherein the ED and ES classifiers are boosted decision trees that use an AdaBoost.M1 algorithm for classifying images.

19. (Original) The system of Claim 11, wherein the machine instructions further cause the processor to determine the boundary pixels using dilation and erosion to fit the smooth curve.

20. (Currently Amended) The system of Claim 11 wherein the machine instructions further cause the processor to fit the smooth curve by:

(a) generating a control polygon for a boundary of a left ventricle in a ventriculogram, with labels corresponding to the anatomic landmarks;

(b) subdividing the control polygon to produce a subdivided polygon having an increased smoothness;

(c) rigidly aligning the subdivided polygon with the anatomic landmarks of the left ventricle; and

(d) fitting the subdivided polygon with the ED and ES image frames and the anatomic landmarks, to produce a reconstructed border of the left ventricle for ED and ES.

LAW OFFICES OF RONALD M. ANDERSON
600 - 108th Avenue N.E., Suite 507
Bellevue, Washington 98004
Telephone: (425) 688-8816 Fax: (425) 646-6314